In the Specification

On page 1, before the Title, kindly delete the following heading:

~~**Description**~~

Kindly replace paragraphs [0001] through [0002] with the following:

Related Application

This is a §371 of International Application No. PCT/JP2005/002145, with an international filing date of February 14, 2005 (WO 2005/080286 A1, published September 1, 2005), which is based on Japanese Patent Application No. 2004-045513, filed February 20, 2004.

~~**Technical Field**~~Technical Field

The ~~present~~ invention relates to a sealing method applied to a glass panel assembly and a structure for the furnace used with this method wherein impure gas and the like may be removed from the glass panel assembly during the sealing process in the furnace by means of coordinated control of temperature and pressure, whereby the volume of impure gas remaining in the glass panel assembly is reduced after the sealing process has been completed.

~~**Related Art**~~Background

The plasma display panel (PDP) manufacturing process includes a preliminary baking step where a seal frit is applied between two glass substrates which are provided with electrodes, inductive components, fluorescent components and partition walls or other like structures; and a seal-forming process step wherein a seal is formed between the glass substrates through the seal frit.

Kindly replace paragraphs [0004] through [0014] with the following:

~~Reference Documents 1 and 2 describe~~Japanese Unexamined Patent Publication Nos. H6-36688 and H11-37660 disclose manufacturing equipment and sealing ovens ~~which are~~ used to seal the glass panel assembly after the preliminary baking process. ~~These documents disclose~~

~~upper~~Upper and lower heaters, or an inductive heater are used. While the sealing processes ~~described by these documents~~ provide for specific temperature control within the oven, there is no specific control of the pressure within the oven and ancillary equipment.

~~[Reference Document 1] Japanese unexamined patent publication No.H6-36688~~

~~[Reference Document 2] Japanese unexamined patent publication No.H11-37660~~

~~**Disclosure of the Invention**~~

~~**Shortcomings Resolved by the Invention**~~

Heating a seal frit results in the emission of impure gas which can have an adverse effect on the performance of a plasma display panel. ~~In order to~~To prevent the impure gas from invading the glass panel assembly during the sealing process, the seal frit is subjected to preliminary baking, before the sealing process, ~~in order~~ to remove impure gas from the seal frit.

Although the preliminary baking, which is executed before the sealing process, has the effect of removing impure gas, raising the temperature of the seal frit again to the sealing temperature during the sealing process, and maintaining that temperature for a specific period of time, results in cracked gas and other types of impure gas adhering to the irregular surface and/or porous of the seal frit. This residual impure gas eventually escapes into the area between the glass substrates. Moreover, the problem is not limited to not only the escape of residual impure gas from the seal frit and also the escape[[s]] of air and gas from other baked materials, such as the partition walls, from the glass panel assembly. If there is a significant volume of impure gas ~~and so on~~ remaining within the glass panel assembly, additional time ~~will be~~is required to execute a subsequent gas removal process. Also, the repeated release of impure gas within the completed plasma display panel ~~will~~ results in degraded light emission characteristics.

Summary

This invention relates to a method of sealing a glass panel assembly by melting a seal frit which is applied between two mutually overlaid glass substrates, including a preliminary heat process where temperature of the glass panel assembly is increased to a preliminary temperature within a forced flow of a heating medium, the preliminary temperature being lower than a temperature at which the seal frit begins to melt, a pressure reduction process where pressure surrounding the glass panel assembly is reduced while the preliminary temperature is maintained, a sealing process where temperature of the glass panel assembly is raised from the preliminary temperature to a sealing process temperature within a forced flow of a heating medium, and a cooling process where the glass panel assembly is cooled within a forced flow of a cooling medium.

This invention also relates to a glass panel assembly sealing process furnace incorporating a transport mechanism as means of transporting a glass panel assembly therethrough and melting a seal frit which is applied between two mutually overlaid glass substrates of the glass panel assembly, including a preliminary heating portion, a pressure reduction portion, a sealing treatment portion and a cooling portion sequentially disposed along a transport direction of the glass panel assembly by the transport mechanism, and pressure adjustment portions capable of increasing and decreasing pressure, installed between the preliminary heating portion and the pressure reduction portion, and also between the pressure reduction portion and the sealing treatment portion, wherein the preliminary heating portion heats the glass panel assembly with a forced flow of a heating medium to a preliminary temperature, the preliminary temperature being lower than a temperature at which the seal frit begins to melt, the pressure reduction portion decreases pressure surrounding the glass panel assembly and maintains the preliminary temperature, the sealing treatment portion heats the glass panel assembly with a forced flow of a heating medium to a sealing process temperature from the

preliminary temperature, and the cooling portion cools the glass panel assembly with a forced flow of a cooling medium.

Brief Description of the Drawings

Fig. 1 is a block diagram of the glass panel assembly sealing method and furnace used therewith showing the sealing process furnace with the temperature and pressure control parameters applied to the method.

Fig. 2 is a cross section of the 1st and 2nd forced flow heating chambers and forced flow cooling chamber of the sealing process furnace shown in Fig. 1.

Fig. 3 is a cross section of the vacuum draw chamber and 1st and 2nd changeover chambers of the sealing process furnace shown in Fig. 1.

Detailed Description

~~The invention, which the inventor has conceived as a result of careful study of the aforesaid shortcomings,~~We provide[[s]] a sealing method applied to a glass panel assembly and a structure for the furnace used in this method. The glass panel assembly sealing method and sealing process furnace used therewith~~, as specified by this invention,~~ enables the removal of impure gas and the like from the glass panel assembly by means of coordinated control of temperature and pressure during the sealing process, and has the effect of further reducing the volume of impure gas remaining in the glass panel assembly after completion of the sealing process.

~~Means of Overcoming Shortcomings in the Related Art~~

The glass panel assembly sealing method ~~specified by the invention~~ includes a preliminary heat process, a pressure reduction process, a sealing process and a cooling process. The preliminary heat process raises [[a]]the temperature of the glass panel assembly, which consists of two glass substrates between which a seal frit has been applied, within a forced flow of a heating medium at a

preliminary temperature which is lower than [[a]]the temperature at which the seal frit begins to melt. The pressure reduction process reduces [[a]]the pressure surrounding the glass panel assembly while the preliminary temperature ~~maintains~~is maintained. The sealing process increases [[a]]the temperature of the glass panel assembly from the preliminary temperature to a sealing process temperature within a forced flow of a heating medium. The cooling process decreases [[a]]the temperature of the glass panel assembly within a forced flow of a cooling medium.

The glass panel assembly sealing process ~~furnace invention~~ incorporates a transport mechanism as a means of transporting a glass panel assembly therethrough and melting a seal frit which is applied between two mutually overlaid glass substrates of the glass panel assembly, and includes a preliminary heating part, a pressure reduction part, a sealing treatment part and a cooling part sequentially disposed along a transport direction of the glass panel assembly by the transport mechanism, and pressure adjustment parts. The preliminary heating part heats the glass panel assembly by a forced flow of a heating medium to the preliminary temperature. The pressure reduction part decreases [[a]]the pressure surrounding the glass panel assembly and maintains the preliminary temperature. The sealing treatment part heats the glass panel assembly by a forced flow of a heating medium to the sealing process temperature from the preliminary temperature. The cooling part cools the glass panel assembly by a forced flow of a cooling medium. The pressure adjustment parts, which are capable of increasing and decreasing pressure, are installed between the preliminary heating part and the pressure reduction part, and also between the pressure reduction part and the sealing treatment part.

~~Effect of the Invention~~

The glass panel assembly sealing method and sealing process furnace used therewith ~~invention~~ enables, during the sealing treatment step, the desired removal of impure gas and the like

from the glass panel assembly by means of coordinated control of temperature and pressure, and thus reduces the amount of residual impure gas and the like within the glass panel assembly after the sealing process has been completed.

~~Preferred Embodiments of the Invention~~

The following will describe, with reference to the attached drawings, ~~preferred embodiments~~selected, representative examples of the glass panel assembly sealing method and sealing process furnace~~ as specified by the invention~~. The glass panel sealing process furnace (hereafter referred to as "the furnace") 1, as described in Figs. 1, 2, and 3, primarily comprises[[;]]:

a transport mechanism 3 which transports a glass panel assembly (hereafter referred to as "glass panel") 2 formed from two mutually overlaid glass substrates between which a seal frit has been applied,

a preliminary heating part in the form of a 1st forced flow heating chamber 4 in which a heating medium is forcibly flowed ~~in order~~ to heat the glass panel 2 to temperature T1 which is a temperature near that at which the seal frit begins to melt,

a pressure reduction part in the form of a vacuum draw chamber 5 in which the pressure therein (pressure P1) is reduced while the preliminary temperature T1 is maintained,

a sealing treatment part in the form of a 2nd forced flow heating chamber 6 in which the temperature of the glass panel 2 is raised from the preliminary temperature T1 to a sealing process temperature T2 while a forced flow of a heating medium is maintained therein,

a cooling part in the form of a forced flow cooling chamber 7 in which the temperature of the glass panel 2 is reduced through a forced flow of a cooling medium, and

pressure adjustment parts, which are capable of both increasing and decreasing pressure, in the form of 1st and 2nd changeover chambers 8 and 9, the former being located between the 1st forced

flow heating chamber 4 and the vacuum draw chamber 5, and the latter being located between the vacuum draw chamber 5 and the 2nd forced flow heating chamber 6. These chambers 4, 5, 6, 7 are disposed along a transport direction of the glass panel 2 by the transport mechanism 3. Temperature can be controlled independently in each of the chambers 4 through 9.

The glass panel 2 is constructed according to conventionally known methods. This ~~embodiment~~example describes the sealing process furnace 1 as a roller hearth type continuous sealing process furnace in which the transport mechanism 3 is a roller hearth type transport mechanism which transports the glass panel 2 through furnace 1. Transport mechanism 3 continuously extends in the furnace 1 from the entrance end of the 1st forced flow heating chamber 4 to the exit end of the forced flow cooling chamber 7. Therefore, multiple glass panels 2, which have been individually placed on trays, are continuously sequentially transported, by transport mechanism 3, from the 1st forced flow heating chamber 4 to the forced flow cooling chamber 7.

1st forced flow heating chamber 4 is structured to include freely open and closable entrance door 10 at the entrance thereto, freely open and closable exit door 11 at the exit there from, and multiple compartments 4a defined by the formation of partition walls 12 along the traversing direction of the transport mechanism 3. The internal temperature of each multiple compartment 4a is controlled in relation to adjacent compartments 4a along the traversing direction of the transport mechanism 3. The internal temperature of the compartment 4a close to the exit side is set higher than that of the compartment 4a close to the entrance side in relation to adjacent compartments 4a. Therefore, the temperature of the glass panel 2 being transported through the 1st forced flow heating chamber 4 (by the transport mechanism 3) can be sequentially raised, within the region extending from the entrance door 10 to the exit door 11, from [[a]]room temperature to the preliminary temperature T1 (~~i.e.~~e.g., 350°C) which is a temperature slightly cooler than that at which the seal frit

begins to melt and expel impure gas. Moreover, the coordinated temperature and pressure control maintains atmospheric pressure (P2) within the 1st forced flow heating chamber 4.

The following describes the structure of each compartment 4a in the 1st forced flow heating chamber 4. Each compartment 4a includes[[;]]:

a furnace case 13,

a thermal barrier 14 formed within the furnace case 13,

a muffle 16 located within the thermal barrier14 to define a channel 15 inner side of the thermal barrier 14 and surrounding the glass panels 2 supported and transported by the rollers 3a,

a recirculation fan 17 located at the top of the furnace case 13 and forcefully circulating the internal thermal medium gas through the channel 15,

a multi-orificed rectifier element 18 located between the glass panel 2 and the recirculation fan 17 within the muffle 16,

a radiant tube burner 19 installed between the thermal barrier 14 and the muffle 16 with the purpose of heating the internal gas therein,

a supply tube 20 which guides a flow of cleansed air into the compartment 4a, and

an exhaust duct 21 through which the internal gas within the compartment 4a is evacuated.

Kindly replace paragraph [0017] with the following:

The following will describe the structure of each compartment 5a in the vacuum draw chamber 5. Each compartment 5a includes[[;]]:

an external shell 24,

a radiation shield 25 located within the external shell 24 and surrounding the glass panels 2 supported and transported by the rollers 3a,

a heater 26 located within the radiation shield 25 to maintain preliminary temperature T1 around the glass panel 2,

a vacuum draw unit 27 connected to the internal region of the external shell 24 as means of drawing a vacuum within the compartment 5a, and

an gas supply duct 28 which is used to return atmospheric pressure (P2) to the compartment 5a, that is, vacuum draw chamber 5. Therefore, each compartment 5a is able to maintain glass panel 2 at the preliminary temperature T1 by means of the radiation shield 25 and heater 26 while a reduced pressure environment is concurrently created therein by means of vacuum draw unit 27.

Kindly replace paragraph [0022] with the following:

The following will explain the glass panel assembly sealing method ~~as specified by this embodiment~~with reference to this example. Glass panel 2, which comprises two mutually overlaid glass substrates between which a seal frit has been applied, is sequentially transported by transport mechanism 3 from the entrance end of the 1st forced flow heating chamber 4 to the exit end of the forced flow cooling chamber 7 through the sealing process furnace 1.

Kindly replace paragraphs [0031] through [0033] with the following:

The method of sealing glass panel assembly and sealing process furnace ~~invention,~~ as described herein ~~the preferred embodiment,~~ have the gas evacuation process and gas evacuation part reducing internal pressure within the furnace to a pressure (P1) at preliminary temperature T1 which is appropriately selected during the heating process to raise a temperature to the sealing process temperature of seal frit. The coordinated control of pressure and temperature makes it possible to properly remove impure gas and the like from a glass panel assembly 2. A glass panel assembly 2 sealed through this method and furnace thus contains a reduced amount of residual impure gas.

While ~~the embodiment describes~~we have described the glass panel assembly 2 as a plasma display panel, ~~the invention may also be employed in the manufacture of~~ other types of multiple layer vacuum insulated glass panel assemblies are within the spirit, intent and scope of this disclosure. Moreover, the transport mechanism 3 is not limited to a roller hearth type transport mechanism as previously described ~~in the previously noted embodiment~~, but may also be structured as a cart or other type transport mechanism.

~~**Brief Description of the Drawings**~~

~~Fig. 1 is a block diagram of a preferred embodiment of the glass panel assembly sealing method and furnace used therewith invention showing the sealing process furnace with the temperature and pressure control parameters applied to the method.~~

~~Fig. 2 is a cross section of the 1st and 2nd forced flow heating chambers and forced flow cooling chamber of the sealing process furnace shown in Fig. 1.~~

~~Fig. 3 is a cross section of the vacuum draw chamber and 1st and 2nd changeover chambers of the sealing process furnace shown in Fig. 1.~~